A STUDY TO COMPARE THE EFFECTIVENESS OF PLYOMETRICS VERSUS STRENGTHENING EXERCISE IN PATIENTS WITH ACHILLES TENDINITIS

Dissertation Submitted To

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY,

CHENNAI

TOWARDS PARTIAL FULFILLMENT AS REQUIREMENT FOR THE DEGREE

MASTER OF PHYSIOTHERAPY

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CERTIFICATE

This is to certify that the research work entitled **"A STUDY TO COMPARE THE EFFECTIVENESS OF PLYOMETRICS VERSUS STRENGTHENING EXERCISE IN PATEINTS WITH ACHILLES TENDINITIS"** was carried out by the candidate with the **(REG NO: 271410142)** Master of physiotherapy student at Thanthai Roever Collage of Physiotherapy, Perambalur, submitted to Tamil Nadu Dr. M.G.R. Medical University, Chennai towards the partial fulfillment as a requirement for the Degree Master of Physiotherapy **(MPT- ORTHPAEDICS).**

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CERTIFICATE

This is to certify that the research work entitled **"A STUDY TO COMPARE THE EFFECTIVENESS OF PLYOMETRICS VERSUS STRENGTHENING EXERCISE IN PATIENTS WITH ACHILLES TENDINITIS"** was carried out by the candidate with the **(REG NO: 271410142)** Thanthai Roever College of Physiotherapy Perambalur under the guidance of me towards the partial fulfillment as a requirement for the degree Master of Physiotherapy Submitted to The Tamil Nadu Dr. MGR Medical University Chennai. **(MPT- ORHOPAEDICS).**

GUIDE

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INTRODUCTION

Achilles tendinitis denotes painful inflammatory and/or degenerative changes in the Achilles tendon, or inflammation of the soft tissue, or inflammation and thickening of the deep retro calcaneal bursa about the Achilles tendon. The tendon maybe identified as tendoachilles, calcaneal tendon or tendocalcaneus “Achilles tendinitis”.

Achilles tendon is the strongest and thickest tendon in the human body. Achilles tendinitis is the major problem in both athletes & normal problem people for propulsion. Achilles tendon contribute the major function for lower limb in running, walking, jumping etc,

The Achilles tendon is the distal extension of the two muscles of the calf, the gastrocnemius and the soleus. The gastrocnemius is the longer of the two muscles and originates on the proximal side of the knee (above the knee). The soleus or shorter muscle of the calf originates distal to the knee joint. Combined these muscles make up the calf. As these two muscles descend to the distal 1/3 of the leg, they combined to form the Achilles tendon.

Most tendon have a tendon sheath that produce fluid, called synovial fluid that baths the tendon in nutrition. The Achilles tendon does not have a true tendon sheath and is merely surrounded by the structure called paratenon. Paratenon is a thin layer of fibrous tissue. The absence of true

tendon sheath presence with both an advantage and a disadvantage for the Achilles tendon.

Achilles tendon tends to rotate as it descends from the conjoined muscles of the heel. The rotation of the tendon is from posterior to medial so that fibers that begin on the posterior leg inset to the medial side of the heel. The anatomical function of this rotation is to invert the heel during plantar flexion of the foot. Just anterior to the Achilles tendon lies the retro calcaneal bursa.

This can become inflamed, leading to pain anterior to the tendon, especially on dorsiflexion of the foot. It is important to differentiate this type of pain from paratenon inflammation or tendinosis. An enlarged bony prominence at the posterior super-lateral aspect of the calcaneus, called the Haglund process, maybe associated with retro calcaneal bursitis but also with insertional tendinitis as well.

Injury to Achilles tendon is maybe due to variety of causes

a) Sports injury
b) Inadequate and incorrect footwear in superficial advential bursa
c) Arthritic disease

Here we are going to discuss about plyometric and strengthening exercise in regaining the function of Achilles tendon.

PLYOMETRICS:

Plyometric is a type of exercise that uses explosive movement to develop muscular power, the ability to generate a large amount of force quickly. For a muscle to cause movement it shortens; this is known as a concentric contraction. There is a maximum amount of power with which a muscle can concentrically contract. However, if the muscle is lengthened "eccentric contraction" just prior to the contraction, it will actually produce more power. This effect requires that the transition time between eccentric contraction and concentric contraction (amortization phase) is very short. It is theorized this extra power is due to the muscle gaining potential energy much like a stretched rubber band. This energy dissipates rapidly, so the action must be quick. The process is frequently referred to as the "stretch shortening cycle", and is one of the underlying mechanisms of plyometric training.

STRENGTHENING EXERCISE:

Strengthening exercise performed in the form of two methods:

1) Isometric
2) Isotonic
   a) Concentric
   b) Eccentric

In variety of situation strengthening exercise play a vital role in improving the joint function. The strengthening exercise for Achilles tendinitis is designed by means of using elastic band.

CAUSES:

The timelines cited below are not binding. Each case should be adjudicated o the evidence provided and its own merits.

i) Familial hypercholesterolemia

   a. This is felt to be irritation secondary to tendon xanthomatosis (A cholesterol deposit)

ii) Loss of heel fat pad because of ageing

   a. This is felt to be due to reduced shock absorbency with loss of the heel fat pad.

iii) Foot or leg alignment problem

   a. Many foot or leg alignment problems may contribute to the evolution and/or aggravation of Achilles tendonitis, including:

      i. Haglund‘s deformity of calcaneus
      ii. Varus deformity of hind foot
      iii. Valgus deformity of hind foot
      iv. Cavus deformity of foot
      v. Fore foot valgus
      vi. Rigid plantarly flexed first ray of foot

iv) Participation in sports and physical activity

   a. For participation in sports and physical activity to cause or aggravate Achilles tendonitis or Achilles bursitis, the following should be evident:

      i. Signs/symptoms of Achilles tendonitis or Achilles bursitis should occur during the activity or within 7 days of cessation of the activity; and
      ii. Signs/symptoms should be ongoing or recurrent for a period of at least 6month to be consider “chronic” for pension purposes.

iii. A wide range of sports which require movements of the ankle joint, and any activities involving any jumping or running, regardless of quality of footwear, have been identified as causation and/or aggravation factors, example gymnastics, skating, tennis, squash, football, basketball and baseball. The mechanism of injury is considered to be increased stress on the Achilles tendon.

v) Inadequate and incorrect footwear in superficial adventitial bursa.

a. This is restricted to superficial adventitial bursa. Symptoms occur at the time of the wearing a footwear.

b. Inadequate footwear has been described as showing excessive medial wear, excessive lateral sole wear, inflexible fore foot –sole stiffness, poor- fitting or excessively flexible heel "counter" (a piece of material inserted between the lining and outside of a shoe or boot quarter to make it stiff), and ineffective shock absorbing qualities. Incorrect footwear is commonly associated with shoes and poorly shaped.

vi) Arthritic diseases.

a. Sero negative arthritic diseases can cause a disorder of the muscular/tendonous attachment to bone and cause or aggravate Achilles tendonitis or Bursitis. These arthritic conditions include:

i. Reiter's syndrome

ii. Psoriatic arthritis

iii. Ankylosing spondylitis
iv. Behcet's syndrome
v. Intestinal arthropathies
vi. Rheumatoid arthritis
vii. Gout

RISK FACTORS:

A risk factor is something that increases your chance of getting a disease or condition.

a) Improper or badly worn foot wear
b) Improper warm-up for your activity
c) Inflexibility of the calf muscles
d) Improper cool-down
e) An improper training program

Intrinsic pathology of tendonosis:

Histrological changes in the Achilles tendon include changes to the extra cellular and intracellular matrices. These include collagen degeneration, fiber disorientation and increased mucoid ground substance, but no increase in inflammatory cells occurs. Focal hyper cellularity and vascular proliferation are usually presents. The number and morphologic variations of tenocytes increases (kannus, 1991). Also increased is the number of apoptotic (dead) cells, both in the degenerative and in the ruptured tendon (yuan, 2003) the proportion of type III collagen is also increased in the degenerate tendon.

Pathologically, Achilles degeneration has been described as lipoid or mucoid (jozsa, 1997). In mucoid degeneration, the tendon becomes more brown or grey continuing neo vascularization and conversely, poor results are associated with continuing neovascularization (Ohburg, 2004 April; Alfredson, 2003). Tendon rupture is almost always the terminal event in the ongoing degenerative process of the tendon, as confirmed in histologic studies of ruptured tendon (Cetti, 2003yuk).

Symptoms:

Symptoms may include:

- Tenderness usually located one or two inches above the point where the Achilles tendon attaches to the heel bone (noticeable in the morning upon rising)
- Stiffness that gradually eases as the tendon is warmed up
- Pain after activity that gradually worsens
- Radiating or localized pain along the tendon during and/or after running
- Swelling in the area of the Achilles

There may be inflammation of the Achilles tendon which shifts as the tendon moves with dorsi-flexion and plantar-flexion of the foot.

Inflammation – Pain and tenderness in the tendon. Achilles tendon pathology may also occur without inflammation, e.g., in metabolic or rheumatic disorder. The tendon may become tender and thickened as Achilles tendonitis becomes chronic.

Inflammation of the soft tissue - Surrounding the Achilles tendon also produces 1) pain, 2) diffuse swelling over the tendon, 3) crepitus on moving the foot, 4) tenderness

Retro calcaneal bursitis – 1) Local pain and swelling, palpable behind the Achilles tendon on the bursal projection.

1) Associated tenderness, thickening of the overlying skin, and signs of local inflammation are found as the retro calcaneal bursitis becomes chronic.
2) In certain cases, e.g., when caused by systemic diseases, the condition maybe bilateral. Medical attention may not be sought until symptoms have been present for sometimes.
3) Because it take a lot of repetitive tensile overload to cause this injury and because it is frequently associated with degenerative tendonosis.
4) Surgical treatment is common.

   The literature has identified a significant number of factors as being causative of, contributory to, or aggravating factors in Achilles tendonitis and bursitis. Because many of the factor is the evolution of the conditions are difficult to modify or to eliminate, the condition may persist over an extended period of time. Thus aggravation is the common feature of the course of the condition as one or more of the factor is successively applied to the existing condition.

Biomechanics:

Most injuries of the Achilles tendon do not result from recent acute injury, but develop gradually over weeks or month. These are “overuse” or “misuse” conditions caused by excessive and/or repetitive motion, often associated with poor biomechanics. The end results is a micro trauma injury: The body is unable to keep up with the repair and re-strengthening needs, so the tissue begins to fail and becomes symptomatic. If it is not very painful (or when the pain is eliminated by medication), continued stress eventually can lead to complete failure, with a resulting acute tear of the tendon.

The Achilles tendon insertion on the calcaneus is medial to the axis of the sub-talar joint, making the calf muscles the most powerful supinator of the sub-talar joint. Therefore, when excessive pro nation occurs, the tendon eventually undergoes overuse degeneration and inflammation. Clement, et al., described how “pro nation generates an obligatory internal tibial rotation, which tends to draw the Achilles tendon medially. Through slow motion, high- speed cinematography, we have seen that pro nation produces a whipping action, or bowstring effect, in the Achilles tendon. The whipping action, when exaggerated may contribute to micro tears in the tendon, particularly in its medial aspect, and initiate an inflammatory response.”

RANGE OF MOTION:

Normal movements for Achilles tendon are plantar flexion. The normal movement at ankle from position of ankle that is right angled position is,

a) Plantar-flexion (0-50^0)

In fully plantar flexed position of the ankle, the posterior and narrowest part of the dome of talus articulates with the ankle mortis. In this position some ride rocking and inversion/eversion of the ankle can be passively demonstrated.

b) Dorsi -flexion (0-30^0-35^0)

When the joint is dorsiflexion, the widest anterior part of the talus is wedged tightly between the two malleoli provided strong stability of the joint.

c) Inversion (0-20^0-25^0)

Inversion is a movement in which the medial border of the foot is elevated, so that the sole faces medially.

d) Eversion (0-10^0-15^0)

Eversion is the movement in which the lateral border of the foot is elevated, so that the sole faces laterally.

Method:

- Patient sits at the edge of the bed, keeping his knee bend about 90^0 and both his leg and feet hanging down the edge of the table.
- Examiner sitting at one side of the patient supports the lower part of the leg from behind.

- ❖ Patient is then asked to alternate dorsi flex and plantar flex both the ankles simultaneously from the zero position. Note the excursion of the hind foot in either direction in both the foot.

Clinical features:

The cardinal symptom of Achilles tendinitis is pain. Generally it occurs at the beginning and end of the training session, with a period of diminished discomfort in between. In the acute phase, the tendon is diffusely swollen and oedematous, and on palpation tenderness is usually greatest 2-6 in cm proximal to the tendon insertion. Sometimes, fibrin precipitated from the fibrinogen- rich fluid around the tendon can results in palpable crepitation.

In chronic cases, exercise- induced pain is still the cardinal symptoms, while crepitation and effusions diminished. A tender, nodular swelling is usually present in chronic cases and is believed to signify tendinosis.

Factors that influence the occurrence of plantar fasciitis are obesity, sudden weight gain, tight Achilles tendon is increased or change in physical activity, shoe with poor support change in running or walking surface, occupation involves prolonged weight bearing and foot structures. It is most common in runners, other athletes and dancers.

DIAGNOSIS:

XRAYS: To see if there is calcium in the tendon. In some cases, the tendon will not tear, but instant, it will literally pull a piece of calcaneal bone off of the rest of the calcaneus.

MRI SCAN: To view area of the interior damage of the tendon. For a tendon rupture, the area of the rupture is often swollen, tender, bruised (ecchymotic) and may actually have a palpable gap in the tendon.

PHYSICAL EXAMINATION:

TEST FOR ACHILLES TENDON RUPTURE:

Ask the patient to stand on a tip toes. In case of weak Achilles there will be lag in lifting with heel. In case of partial rupture, the patient will complaint of pain at the site in complete rupture, the lag will be much more, but standing on tip toe is never completely absent. Along with this, gap can also be felt at the rupture site in which can insinuate the examining finger. At both end of the gap the rounded end of rupture tendon can be felt in late causes. In late neglected causes, the end feel like adder heads.

THOMPSON'S TEST:

The patient lies prone or kneels on a chain with the feet over edge of the table or chair while the patient is relaxed, the examiner squeeze the calf muscle a "+VE" test is indicated by absence of plantar flexion when the muscle is squeezed and is indicative of a ruptured Achilles tendon.

STAIR (CLIMBING) TEST:

Ask the patient to put the fore foot of normal leg on the edge of the step and lift himself upon that leg as in chair climbing repeat the test with

the injured leg patient will unable to lift himself upon that leg due to discontinuity of Achilles tendon.

PHYSICAL THERAPY:

1. Icing
2. Stretching
3. Ultrasound therapy
4. Ionotophoresis
5. Deep friction massage
6. Joint mobilization
7. Strengthening exercise
8. Low level laser

Over 98% of the time, Achilles tendenitis can be controlled by this treatment and surgery can be avoided.

NEED FOR THE STUDY

Achilles tendon is common in all patients who is undergoing sports activity or in normal wear and tear situation. So they need of treatment which top make early progression and to plyometric where treating in patient who give early better result to the patient in Achilles tendinitis. Hence there is need for a study to compare the effectiveness of this treatment.

HYPOTHESIS

NULL HYPOTHESIS:

It can be hypothesized that plyometric is effective than strengthening exercise in the management of Achilles tendinitis.

ALTERNATIVE HYPOTHESIS:

- It can be hypothesized Strengthening Exercise is effective than Plyometric training in the management of Achilles tendinitis.

- It can be hypothesized that both plyometric and strengthening exercises are equally effective in the management of Achilles tendinitis.

AIM AND OBJECTIVES

AIM:

To Compare the Effectiveness of Plyometric Training with Strengthening Exercise in patients with Achilles tendinitis.

OBJECTIVES:

- To study the effect of strengthening exercises on VAS in patients with Achilles tendinitis.
- To study the effect of strengthening exercises on Vertical jump Test in patients with Achilles tendinitis.
- To study the effect of Plyometric training on VAS in patients with Achilles tendinitis.
- To study the effect of Plyometric training on Vertical jump Test in patients with Achilles tendinitis.
- To compare the effect of VAS with Vertical Jump test in patients with Achilles tendinitis.

REVIEW OF LITERATURE

- **Br J Sports Med.2006 Nov 24: Plyometric training in Achilles tendonitis –and its relation with microcirculation. Knoblock K**

Plyometric training has been shown to reduce pain and gain function in patient with chronic Achilles tendinopathy. However, currently no data are available regarding any potential adverse effect of Plyometric intervention on Achilles tendon microcirculation. 59 patients were selected. The Baseline tendon microcirculation at four distinct tendon positions from the insertion to the proximal mid-portion area was assessed using a laser Doppler system for capillary blood flow, tissue oxygen saturation and post capillary venous filling pressure. A12-week-daily painful home-based eccentric training regimen was initiated (3×15 repetition per tendon and day). Achilles tendon oxygen saturation was not decreased after the 12-week-eccentric-training regimen throughout the insertion to the proximal mid-portion. No Achilles tendon rupture nor any interruption during the eccentric training as noted among the 59 patients. Daily plyometric training for Achilles tendinopathy is a safe and easy measure with beneficial effects on the microcirculation rupture nor any interruption during the eccentric training as noted among the 59 patients. Daily plyometric training for Achilles tendinopathy is a safe and easy measures with beneficial effects on the microcirculatory tendon levels without any evident adverse effects in both, mid-portion and insertional Achilles tendinitis.

- **Knee surg sports Traumatol Arthrosc. 2003 Sep; 11(5):327-33.** Chronic Achilles tendon pain treated with eccentric calf muscle training. **Fahlstrom M, Jonsson P, Lorentzon R, Alfredson H.** Department of surgical and pre-operative sciences, sports medicine, Umea University, 90187, Umea, Sweden.

  Injuries involving the Achilles tendon and manifested as chronic tendon pain are common, especially among recreational athletes. The aim of this prospective study was to investigate if the previously achieved good clinical results could be reproduced in a large group of patients, and also to investigate the effects of eccentric of calf muscle training in patients with chronic insertional Achilles tendon pain. 78 consecutive patients having chronic painful Achilles tendinosis at the mid-portion (2-6cm level) in a total of 101 tendon (55 unilateral and 23 bilateral), and 30 consecutive patients with chronic insertional Achilles tendon pain in 31 tendon (29 unilateral and 1 bilateral), were treated with eccentric calf muscle training for 12 weeks. Most patients were recreational athletes. Evaluation of the amount of the tendon pain during the activity was recorded on a visual analogue scale (VAS), before and after treatment. Our conclusion is that treatment with eccentric of calf muscle training produced good clinical results in patients with chronic painful mid-portion Achilles tendinosis. But not in patients with chronic insertional Achilles tendon pain.

- **Br J Sports Med.2006 Oct 11:** Tendon and paratendon Achilles microcirculation in Plyometric training and an Achilles wrap in insertional and mid-portion tendinopathy – a randomized trial. **Knobloch K, Schreibmueller L, Jagodzinski M, Zeichen J, Vogt PM, Kretteck C. Trauma Department, Hannover Medical School, Germany.**

  Aim: Neo vascularization is encountered in painful Achilles tendinitis. To what extent an Achilles wrap in addition to Plyometric training changes parameters of tendon and paratendon microcirculation in insertional and mid-portion tendinopathy is not known. Study design Randomized clinical trial Methods 112 subjects were recruited and randomized in group A performing 12 weeks of 3 times Plyometric training with Achilles wrap (Air Heel (TM)), AIRCAST, 54 tendon of 54 patient), while group B performed the same eccentric training(64 tendons of 59 patient). Tendon and paratendon microcirculation mapping was performed using combined Laser-Doppler and spectrophotometry. Conclusion The Plyometric training was superior to eccentric training regarding increase of tendon and para tendon oxygenation and reduction of post capillary venous filling reassures facilitation venous outflow than eccentric training. Pain was not significantly different between both regimens.

- **Br J Sport Med.2004 Feb:38(1):8-11:discussion 11.** Plyometric training in patients with chronic Achilles tendinosis: Normalized tendon structure and decreased thickness at follow up. **Ohberg L, Lorentzon R, Alferdson H,** Department of radiation Sciences, Diagnostic Radiology, Umea University, Umea, Sweden.lars.ohberg.us@vll.se

  The Objective of the study was to prospectively investigate tendon thickness and tendon structure by Ultrasonography in patients treated with Plyometric training for chronic Achilles tendinosis located at the 2-6 cm level in the tendon. The patients were examined with grey scale ultra sonography before and 3.8 years (mean) after the 12 weeks eccentric training regimen. At follow up, a questionnaire assessed present activity level and satisfaction with treatment. The result suggested that twenty six tendons in twenty five patients (19 men and 6 women) with a mean age of 50 years were selected. The study concluded that Ultrasonography follow up of patients with mid-portion painful chronic Achilles tendinosis treated with Plyometric training showed a localized decreased in tendon thickness and a normalized tendon structure in most patients. Remaining structural tendon abnormalities seemed to be associated with residual pain in the tendon.

- **Am J Sports Med.2004 Jul-Aug: 32(5):1286-96. Epud 2004 May.** Plyometric training of the gastrocnemius -sole us complex in chronic Achilles tendinitis result in decreased tendon volume and

intratendinous signal as evaluated by MRI. **Shalabi A, Kristoffersen-Wilberg M, Svensson L, Aspelin P, Movin T,** Karolinska University Hospital, Huddinge Karolinska Institute, Stockholm, Sweden.adel.shalabi@cfss.ki.se**.** The background of the study was based on satisfactory treatment results have been reported after Plyometric training in patients with chronic Achilles tendonitis. The methodology used in the study was using magnetic resonance imaging, the Achilles tendons were investigated in 25 patients (16 men and 9 women) ranging in age from 28 to 70 years (median, 51 years) before and after training. Five different magnetic resonance imaging sequences were used. The study concluded that Plyometric training resulted in decreased tendon volume and intra tendinous signal and was correlated with an improved clinical outcome.

- **Scand J Med Sci Sports.2004 Oct: 14(5):286-95.** Clinical improvement after 6 weeks of eccentric exercise in patients with mid-portion Achilles tendinitis—a randomized trial with 1-year follow up. **Ross EM, Engstrom M, Lagerquist A, Soderberg B.** Department of orthopedics, Lund University Hospital, SE-221 85 Lund, Sweden. Ewa.Rose@ort.lu.se**.** Achilles tendonitis is common and treatment with eccentric exercises seems promising. Forty-four patients were recruited from primary care (mean age: 45 years; 23 women; 65% active in sports) and randomized to three treatment groups for 12 weeks: eccentric exercise, a night splint or a combination of both treatment. Pain and function were evaluated at 6, 12, 26 and 52 weeks by the Foot and Ankle Outcome Score. At 6 weeks, the eccentric group reported a significant pain reduction. We conclude that

eccentric exercises seem to reduce pain and improve function in patients with Achilles tendinitis. Our results are in line with previous studies and strengthen the recommendation that patients should undergo an eccentric exercise program prior to considering other treatment such as surgery.

- **Knee surg Sports Traumatol Aarthrosc. 2001; 9(1):42-7** Superior short-term results with eccentric calf muscle training compared to concentric training in a randomized prospective multicenter study on patients with chronic Achilles tendinitis. **Mafi N, Lorentzen R, Alferdson H.** Department of Surgical and Pre operative Science, Umea University, Sweden. In a previous uncontrolled pilot study we demonstrated very good clinical results with eccentric calf muscle training on patient with painful chronic Achilles tendinosis located at the 2- 6 cm level in the tendon. In the present prospective multicenter study (Sundsvall and Umea) patients with painful chronic Achilles tendinosis at the2-6 cm level in the tendon were randomized to treatment with either an eccentric or a concentric training regimen for the calf muscles. The study included 44 patient, with 22 patients (12 men, 10 women; mean age 48 years) in each treatment group. The amount of pain during activity (jogging or walking) was recorded by the patients on a (VAS), and patient satisfaction was assessed before and after treatment. The patient were instructed to perform their eccentric or concentric training regimen on a daily basis for 12 weeks. The results after treatment with eccentric training was significantly better (P is greater than 0.002) than after concentric training. The good clinical results previously demonstrated in the pilot study with

eccentric calf training on patient with chronic Achilles tendinitis, were thus reproduced in this multicenter, showing superior results to treatment with concentric training.

- **Scand J Med Sci Sports. 2001 Aug; 11(4):197-206.** Eccentric overload training for patient with chronic Achilles tendon pain—a randomized controlled study with reliability testing of the evaluation methods. **Silbernagel KG, Thomee R, Thomee P, Karlsson J.** Sport rehab—Physical Therapy& sports Medicine Clinic, Goteborg, Sweden. The purpose was to examine the reliability of measurement techniques and evaluate the effect of a treatment protocol including eccentric overload for patients with chronic pain from the Achilles tendon. Thirty-two patients with proximal achillodynia (44 involved Achilles tendons) participated in tests for reliability measures. Evaluations were performed after six weeks of treatment and after three and six months. The evaluation performed by a physical therapist unaware of the group the patients belonged to, consisted of a questionnaire, a range of motion test, a jumping test , a toe-raises test, a pain on palpation test and pain evaluation during jumping, toe-raises and at rest. A follow-up was also performed after one year. At the one year follow-up there were significantly more patients in the experiment group, compared with the control group, that were satisfied with their present physical activity level, considered themselves fully recovered, and had no pain during or after physical activity. The measurement techniques and the treatment protocol with eccentric overload used in the present study can be recommended for patients with chronic pain -from the Achilles tendon.

- **Clin Sports Med.1992 Jul; 11(3):601-24.** The use of eccentric training and stretching in the treatment and prevention of tendon injuries. **Fyfe I, Stanish W D.** Department of surgery, Dalhousie University, Halifax, Nova Scotia, -Canada. Tendon injuries are a common consequence of either sports or daily routine activity. Most people will suffer at least one tendon injury in his -or her lifetime. It is therefore prudent to understand the different ways to load tendon and the ways in which the muscle-tendon-bone unit responds to these stresses. By maximizing tendon training and rehabilitation, one can maximize the stresses (eccentric) a tendon will withstand. This article provides an explanation of these principles.

- **Br J Sports Med.2006 Oct 24;** Chronic Tendinitis: Effectiveness of Eccentric Exercise. **Woodley BL, Newsham-west RJ, Baxter GD.** Centre of Physiotherapy Research, School of physiotherapy, University Of Otaga, Dunedin, New Zealand. This review demonstrates the dearth of high quality research in support of the clinical effectiveness of eccentric exercise over other treatment in the management of tendinitis. Further adequately powered studies that include appropriate randomization procedures, standardized outcome measures and long-term follow-up are required.

DESIGN AND METHODOLOGY

STUDY DESIGN:

Experimental Study

STUDY SETTING:

Hospital approved by the guide and college.

STUDY DURATION:

The study was conducted over a period of 6 weeks.

SAMPLING:

Convenient sampling method

SAMPLE POPULATION:

All the Achilles tendinitis of ankle joints with the age group of 18-25 was selected.

INCLUSION CRITERIA

- Patient who diagnosed to have Achilles tendinitis are selected.
- The patient are selected between the age group 18-25 years
- Only males are selected
- Both the right and left sides are included

EXCLUSION CRITERIA

Age below and above 18-25 years are excluded

- Females are excluded
- Patient other than Achilles tendinitis are excluded

MATERIAL AND METHODOLOGY

Material following equipment and material were used in the study treatment were going for Achilles tendon.

Material used:

- Inch tape
- Vertical jumping regimen
- Pain scale- Visual Analog Scale

Procedure

Sample size 30 subject were selected using convenient sampling method. Then divided into two groups, one for experiment group & other one is control group.

The plyometric was applied to experimental group & strengthening exercise for control group.

Treatment Procedure:

Experimental Group:

a) Plyometric

A sample of 15 subjects was selected according to the convenient sampling method.

High intensity, low volume plyometrics workout should be performed 1-2 times per week. By well-conditioned athletes only, ideally on same day as you perform your weight training [another high intensity activity]

Plyometrics workouts can be performed anywhere from 1-3 days per week.

Dr. Verkhoshansk's original guidelines for plyometrics were that advanced should not perform more than 40 reps of depth jumps or depth drops per workout and should not perform more than 3 such workouts per weeks, with at least 1 full day in between each workout day. That means at least 48 hours in between workout and a maximum of 120 reps of depth jumps or their variation per week.

1-3 Weeks:

MONDAY:

- Ankle Hops-3 Sets × 30 Reps
- Line Jumps- 3 Sets × 15 Reps
- Full squat -2-3 Sets× 10-12 Reps

WEDNESDAY:

- Ankle Hops – 3 Sets × 30 Reps
- Rim Jumps -3 Sets × 8Reps
- Split Squats -2-3 Sets × 10 -12 Reps

FRIDAY:

- Ankle hops - 3 Sets × 30 Reps
- Line Jumps- 3 sets × 15 Reps
- Full squats – 2-3 sets × 10-12 Reps

3 – 6 Weeks:

MONDAY:

- Line Jumps – 3 Sets × 15 Reps
- Rim Jumps - 3 Sets × 10 Reps
- Squat jumps – 4 Sets × 8 Reps
- Full squats - 3 Sets × 10 Reps
- Snatch – Grip Deadlifts – 3 Sets × 10 Reps
- Bench Press – 3 Sets × 10 Reps
- Rows – 3 Sets × 10 Reps

WEDNESDAY:

- Ankle Hops – 3 Sets × 30 Reps
- Standing Broad Jumps – 4 Sets × 6 Reps
- Tuck Jumps – 3 Sets × 10 RepS
- Split Squats – 2- 3 Sets × 10 -12 Reps

FRIDAY:

- Line Jumps – 3 Sets × 15 Reps
- Ankle Jumps – 5 Sets × 3 Reps
- Squat Jumps – 4 Sets × 8 Reps
- Full Squats – 2- 3 Sets × 10 -12 Reps

Control Group:

Strengthening Exercise:

A sample of 15 subjects was selected according to the convenient sampling methods.

The patients were instructed to perform 3 sets of 15 repetitions of each exercises, and to do this twice daily [3 sets with straight knee & 3 sets with best knee].

The exercise program as follow

- Standing with both feet on a step, with only the forefoot on the step, the patient performed a toe raise using the non-injured side.
- All the body weight was then shifted onto the injured side and the patient slowly lowered the heel to a position beneath the forefoot.
- No concentric contraction was performed with the affected side. Instead the non-injured side was again fully loaded in order to get back to the starting position.
- The exercise was performed both with the straight as well as with knee flexed.

Non weight bearing pain free active range of motion was started with single plane and progressed to multi planar motion.

It Includes

1) Self-resistance to plantar flexion using elastic band.
2) Self-resistance to dorsi flexion using elastic band.
3) Resistance to eversion using elastic band.
4) Resistance to inversion using elastic band.

Documenting the result such as pain and vertical jumping.

Visual Analogue Scale:

The VAS consists usually of a 10 cm line labeled at 0 by the patients with no pain and most intense pain imaginable subjects indicates 10 of their pain magnitude by making the line at the appropriate point. The distance in anti-meters from low end of VAS to the patient mark is used as numerical index of the

Severity of pain:

A VAS for measuring pain or other symptoms. The patient is instructed to mark a line at the point that corresponds to the degree if pain or severity of symptoms that experienced.

Vertical Jumping:

Method:

- The sample stands side on to a well and reaches up with hand closet to the wall.
- Keeping the felt flat on the group, the point of the fingertips is marked (or) recorded.

- The sample then stand away from the wall, & jumps vertically as high as possible using both arms and legs to assist in projecting the body upwards.
- Attempt to touch the wall at the highest point of the jump.

Scoring:

The jump height jump is usually recorded as the score in distance. This height is measured as "standing reach (H reach)". "Jump height (H sergeant)", is calculated as the difference between the jump height & the standing reach height measures in centimeters.

H sergeant = H touch – H reach.

Rating:

Excellent	**>70**	**>60**
Very good	61-70	51-60
Above average	51-60	41-50
Average	41-50	31-40
Below average	31-40	21-30
Poor	21-30	11-20
Very poor	<21	<11

These are also calculation to convert jump height into a power score.

DATA ANALYSIS AND INTERPRETATION

STATISTICAL TOOL:

1. PAIRED 't' TEST :

To calculate the parameter we will use the following formula:

$$t = \frac{\bar{d}}{\sqrt{s^2 / n}}$$

Where

- 'd bar' is the mean difference between two samples
- S^2 is the sample variance,
- n is the sample size and
- t is a paired sample t-test with n-1 degrees of freedom.

An alternate formula for paired sample t-test is:

$$t = \frac{\Sigma d}{\sqrt{\frac{n\left(\Sigma d^2\right) - \left(\Sigma d\right)^2}{n-1}}}$$

2. UNPAIRED 't' TEST :

This test is used only when it can be assumed that the two distributions have the same variance. (When this assumption is violated, see below.) The *t* statistic to test whether the means are different can be calculated as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{s_{X_1X_2} \cdot \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where

$$s_{X_1X_2} = \sqrt{\frac{(n_1 - 1)s_{X_1}^2 + (n_2 - 1)s_{X_2}^2}{n_1 + n_2 - 2}}.$$

Note that the formulae above are generalizations of the case where both samples have equal sizes (substitute n for n_1 and n_2).

$s_{X_1X_2}$ is an estimator of the common standard deviation of the two samples: it is defined in this way so that its square is an unbiased estimator of the common variance whether or not the population means are the same.

In these formulae,

- n = number of participants,
- 1 = group one, 2 = group two.
- $n - 1$ is the number of degrees of freedom for either group, and
- The total sample size minus two (that is, $n_1 + n_2 - 2$) is the total number of degrees of freedom, which is used in significance testing.

Table 1:

Mean of Pre and Post Scores of Pain on VAS in Control Group (Strength Training)

S. No	Assessment	Mean Values	Mean Difference	SD	t – value	p - Value
1	Pre Score	8.066	5.133	0.6399	31.067	0.000
2	Post Score	2.933				

Graph 1:

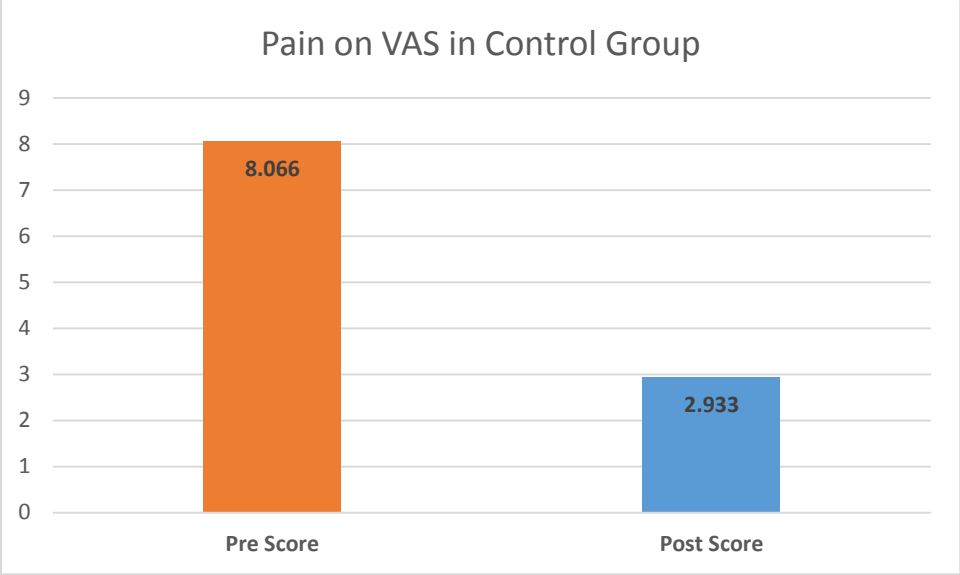


Table 2:

Mean of Pre and Post Scores of Vertical Jump test in Control Group (Strength Training)

S. No	Assessment	Mean Values	Mean Difference	SD	t – value	p - Value
1	Pre Score	13.2	11.27	0.4577	95.327	0.000
2	Post Score	24.47				

Graph 2:

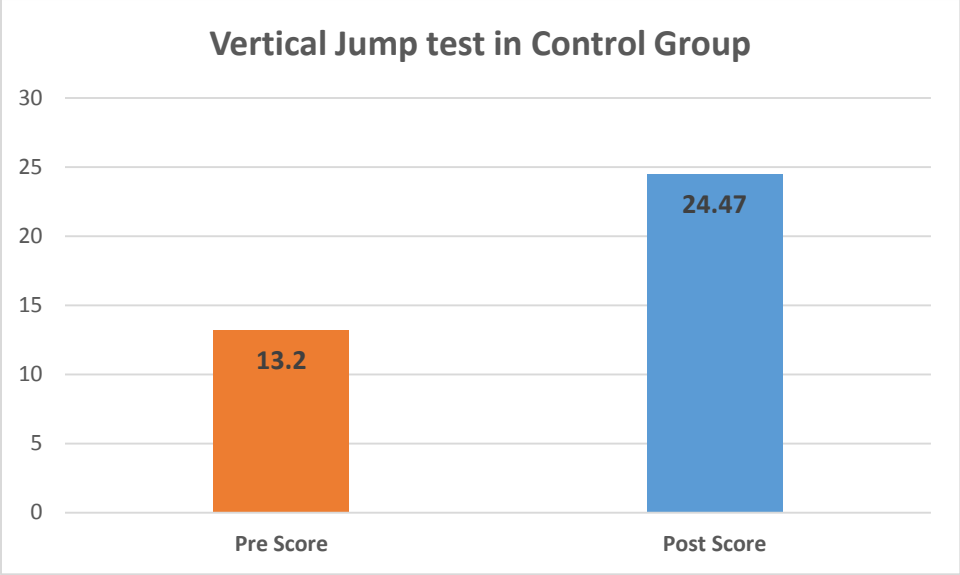


Table 3:

Mean of Pre and Post Scores of Pain on VAS in Experimental Group (Plyometric Training)

S. No	Assessment	Mean Values	Mean Difference	SD	t – value	p - Value
1	Pre Score	8.133	7.933	0.7988	38.464	0.000
2	Post Score	0.2				

Graph3:

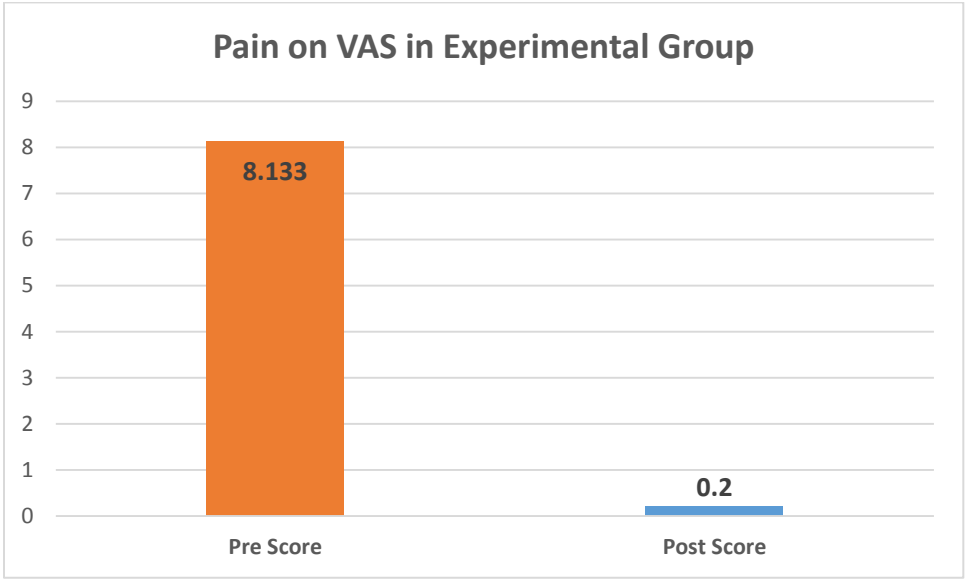


Table 4:

Mean of Pre and Post Scores of Vertical Jump Test in Experimental Group (Plyometric Training)

S. No	Assessment	Mean Values	Mean Difference	SD	t – value	p - Value
1	Pre Score	9.067	24.6	1.549	61.500	0.000
2	Post Score	33.67				

Graph 4:

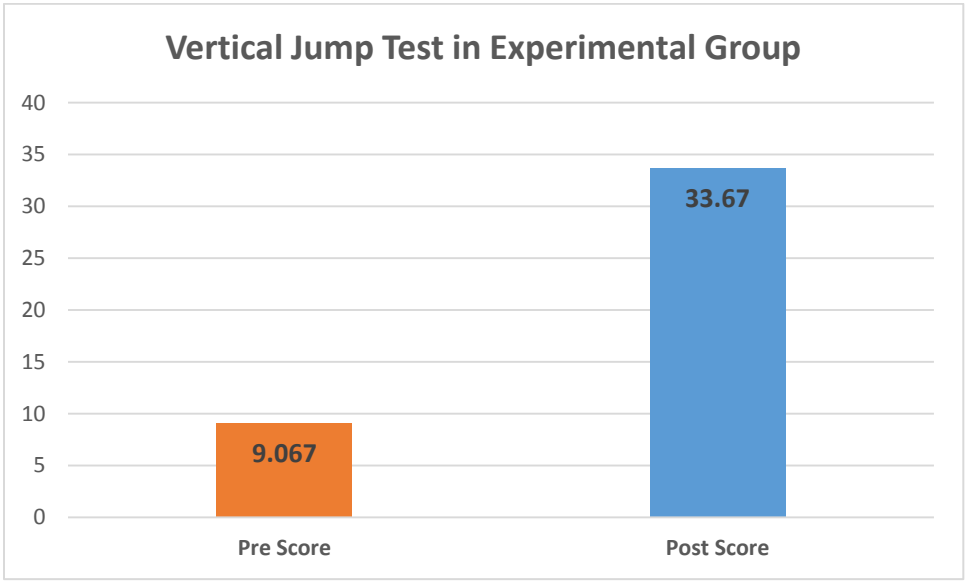


Table 5:

Mean Difference of Control and Experimental group in Pain on VAS

S. No	Group	Mean Difference	Difference	SEM	t – value	p - Value
1	Control	5.133	2.8	0.2643	10.595	0.000
2	Experimental	7.933				

Graph 5:

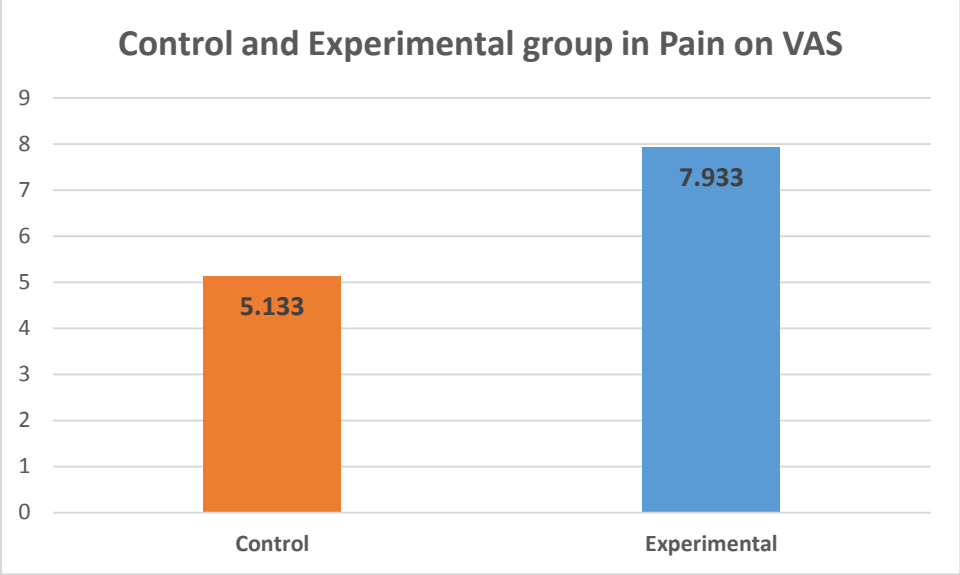
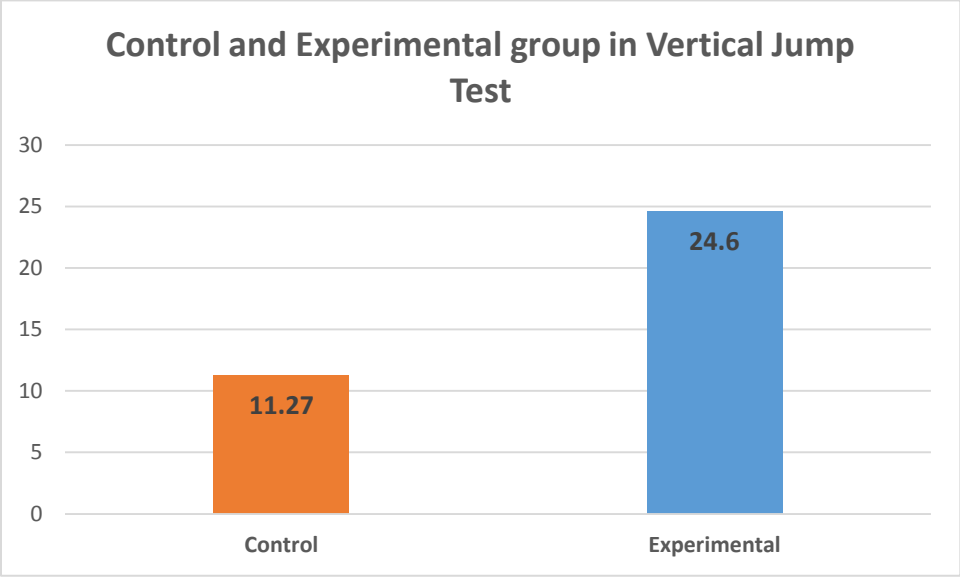


Table 6:

Mean Difference of Control and Experimental group in Vertical Jump Test

S. No	Group	Mean Difference	Difference	SEM	t – value	p - Value
1	Control	11.27	13.33	0.417	31.963	0.000
2	Experimental	24.6				

Graph 6:



RESULT

The aim of the study is to assess the effectiveness of plyometrics v/s strengthening exercise on VAS and vertical jumping in case of Achilles Tendinitis

- **IN THIS ANALYSIS AND INTERPRETATION OF VISUAL ANALOUGE SCALE (VAS) FOR PAIN IN GROUP A.**

  The Paired 't' value of 31.067 was greater than the tabulated 't' value of 4.07 which showed that there was statistically significant difference at 0.000 level between pre v/s post test result. The pre-test mean was 8.066, post-test mean was 2.933 and mean difference was 5.133 which showed that there was statistically significant reduction of pain in patient with Achilles Tendinitis following applications of strengthening exercise, plyometrics in Group A

- **IN THIS ANALYSIS AND INTERPRETATION OF VERTICAL JUMPING IN GROUP A.**

  The paired 't' value 95.327 was greater than the tabulated 't' value of 4.07 which showed that there was statistically significant difference at 0.000 level between pre v/s post test result. The pre-test mean was 13.2, post-test mean was 24.47 and mean difference was 11.27 which showed that there was an improvement in vertical jumping in post test result in response to intervention.

  Based on the study of Aspelin P.et.al., & Movin T.et.al., support the present study in which plyometrics had a beneficial effect on patient with Achilles Tendinitis.

- **IN THIS ANALYSIS AND INTERPRETATION OF VISUAL ANALOUGE SCALE (VAS) IN GROUP B.**

  The paired 't' value 38.464 was greater than the tabulated 't' value of 4.07 which showed that there was statistically significant difference at 0.000 level between pre v/s post test result. The pre-test mean was 8.133 post-test mean was 0.2 and mean difference was 7.933 which showed that there was statistically reduction of following the application of plyometrics.

- **IN THIS ANALYSIS AND INTERPRETATION OF VERTICAL JUMPING IN GROUP B.**

  The paired 't' test value of pre & post-test session of group B was 61.500 and 0.000 level which was greater than the tabulated paired 't' value 4.07. The result showed that there was a statistically significant difference in between pre & post-test. The pre-test mean was 9.067 and post-test mean was 33.67 and pre v/s post-test mean was 24.6 which showed that there was an improvement in vertical jumping in post test result in response to intervention.

The above statistical result showed that there were beneficial in the effects in Achilles Tendinitis with plyometrics.

- **IN THIS ANALYSIS AND INTERPRETATION OF VISUAL ANALOGUE SCALE (VAS) IN GROUP A AND GROUP B.**

The unpaired 't' value 10.595 was greater than the tabulated 't' value of 3.73 which showed that there was statistically significant difference at 0.000 level between the mean difference of Group A and Group B. The pre v/s post-test mean of Group A 5.133 the pre v/s post mean of Group B was 7.933 and mean difference of Group A and Group B was 2.8 which showed that there was statistically significant reduction of pain in patients with Achilles Tendinitis in response to treatment in Group A when compared to Group B.

- **IN THIS ANALYSIS AND INTERPRETATION OF VERTICAL JUMPING IN GROUP A AND GROUP B.**

The unpaired 't' value 31.963 was greater than the tabulated 't' value of 3.73 which showed that there was statistically significant difference at 0.000 level between the mean difference of Group A was 11.27, the pre v/s post-test mean of Group B was 24.6 and mean differences of Group A and Group B was13.33 which showed that there was an improvement in vertical jumping in patient with Achilles Tendinitis in response to treatment in Group A when compared to Group B.

This study was to prove that plyometrics is more effective when compared with strengthening exercise for Achilles tendonitis of ankle joint.

The pain, range of motion & vertical jump post scores shows significant improvement then the pre test scores. The result suggest

that plyometrics gives earlier improvement then the strengthening exercise.

DISCUSSION

30 patients with Achilles Tendinitis were taken and divided into 2 groups Group A and Group B of 15 each.

The selected 30 patients are male. The significant reduction in pain and in significant improvement in vertical jumping was due to plyometric training.

The aim of the study is to assess the effectiveness of plyometrics v/s strengthening exercise on VAS and vertical jumping in case of Achilles Tendinitis

Based on the study of Alferdson. H.et.al., Visual Analouge Scale (VAS) and Plyometrics (Vertical jumping) were used as parameters in the present study.

Plyometrics is a type of exercise that used explosive movements to develop muscular power, the ability to generate a large amount of force quickly.

For a muscle to cause movement, it shorten; this is known as a concentric contraction. There is a maximum amount of power with which a certain muscle can concentrically contract. However, if a muscle is lengthened “eccentric contraction” just prior to the contraction, it will actually produce more power.

This effect requires that the transition time between eccentric contraction and concentric contraction (amortization phase) is very short. It is theorized this extra power is due to the muscle gaining potential energy much like a stretched rubber band.

This energy dissipates rapidly, so the action must be quick. The process is frequently reffered to as the "stretch shortening cycle" and is the one of the underlying mechanisms of plyometric training.

Based on the study of Aspelin P,et.al., & Movin. T.et. al., in which strengthening exercise had a beneficial effects on patients with Achilles tendinitis.

Strengthening exercise performed in the form of two methods

1. Isometric
2. Isotonic
    a. Concentric
    b. Eccentric

In variety of situation strengthening exercise play an vital role in improvement the joint function. The strengthening exercise for Achilles tendinitis are designed by means of using elastic band.

So the severity of pain was assessed by using Visual Analogue Scale (VAS)

The vertical jumping improvement was assessed by using the scoring.

The jump height jump is usually recorded as the score in distance.

1. The evidence to support the effectiveness of plyometrics training for developing muscle strength and power in substantial.
2. There is also evidence indicating the plyometrics training is associated with an increase in a muscle's ability to resist stretch, which may enhance the muscle's dynamic restraint capabilities.
3. In addition, there is promising, but limited, evidence to suggest the plyometrics training may enhance physical performance, and may decrease the incidence of lower extremity injury.

CONCLUSION

Comparing the pain range of motion and vertical jumping values of experimental and control group, it could be seen that significance is much greater when plyometrics is concerned than the strengthening exercise. This means the plyometrics give much earlier improvement than the strengthening exercise.

RECOMMENDATION

1) Increasing time duration of the study.

2) Increasing sample value of the study.

3) To study the effort in players.

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APPENDIX- I

INFORMED CONSENT OF PARTICIPATE VOLUNTARY IN RESEARCH INVESTIGATION

Name :

Age :

Sex :

Occupation :

Address for communication :

Declaration

I have fully understood the nature and the purpose of the study. I accept myself as a subject in this study. I declare that the above information is true and best of my knowledge.

Date : **Signature of the Subject**

Place :

MASTER CHART

Control Group:

Pain:

Name	Age	Pre score	Post score
1)Rajasekar. P	23 yrs	7	2
2)Kesavan. D	22 yrs	8	3
3)Saravanan. P	20 yrs	8	2
4)Naveen. S	19 yrs	9	3
5)John peeter.F	22 yrs	8	4
6)Prakash. K	18 yrs	9	3
7)Senthil. R	21 yrs	8	3
8)Aravind. P	24 yrs	7	2
9)Karthick. S	20 yrs	8	3
10)Balaji. N	22 yrs	9	4
11)Venkatesh. A	19 yrs	8	3
12)Kavin. D	20 yrs	7	2
13)santhosh. R	21 yrs	8	4
14)Dhanapalan.M	25 yrs	9	3
15)Ramesh. V	19 yrs	8	3

Vertical jumping:

Name	Age	Pre score	Post Score
1)Rajasekar. P	23 yrs	14	26
2) Kesavan. D	22 yrs	11	23
3)Saravanan. P	20 yrs	14	25
4)Naveen. S	19 yrs	14	25
5)John Peeter. F	22 yrs	15	26
6)Prakesh. K	18 yrs	13	24
7)Senthil. R	21 yrs	12	23
8)Aravind. P	24 yrs	11	22
9)Karthic. S	20 yrs	14	25
10)Balaji. N	22 yrs	13	24
11) Venkatesh.A	19 yrs	15	27
12)Kavin D	20 yrs	14	25
13)Santhosh. R	21 yrs	12	23
14)Dhanapalan.M	25 yrs	11	23
15) Ramesh. V	19 yrs	15	26

Experimental group:

Pain:

Name	Age	Pre score	Post score
1) Gopi. K	19yrs	9	0
2) Anand. C	20 yrs	8	1
3)Sivakumar. B	22 yrs	7	0
4)Malik.G	18 yrs	8	0
5)Kumaran. R	21 yrs	9	0
6)Harish. M	23 yrs	7	0
7)Bashir. J	20 yrs	8	0
8)Rithic. A	18 yrs	8	0
9)Ravikumar.S	23 yrs	9	1
10)Mahesh. K	19 yrs	9	0
11)Chandrasekar.p	24 yrs	8	0
12)Dharmesh. G	18 yrs	9	0
13)Suresh. D	22 yrs	8	0
14)Rajesh. T	21 yrs	7	0
15)Nizham. H	25 yrs	8	1

Vertical Jumping:

Name	Age	Pre score	Post score
1)Gopi. K	19 yrs	6	30
2)Anand. C	20 yrs	8	35
3)Sivakumar. B	22 yrs	10	35
4)Malik. G	18 yrs	12	35
5)Kumaran. R	21 yrs	10	35
6)Harish.M	23 yrs	8	30
7)Bashir. J	20 yrs	10	35
8)Rithic. A	18 yrs	10	35
9)Ravikumar.S	23 yrs	8	35
10)Mahesh. K	19 yrs	12	35
11)Chandrasekar.P	24 yrs	6	30
12)Dharmesh. G	18 yrs	12	35
13)Suresh. D	22 yrs	8	35
14)Rajesh. T	21 yrs	10	35
15)Nizham.H	25 yrs	6	30

Strengthening Exercises

PLYOMETRIC TRAINING

VERTICAL JUMP TEST